ALFALFA IN MANITOBA

EXPERIMENTAL RESULTS

FROM THE

DOMINION EXPERIMENTAL FARM, BRANDON

By S. J. SIGFUSSON, B.S.A.

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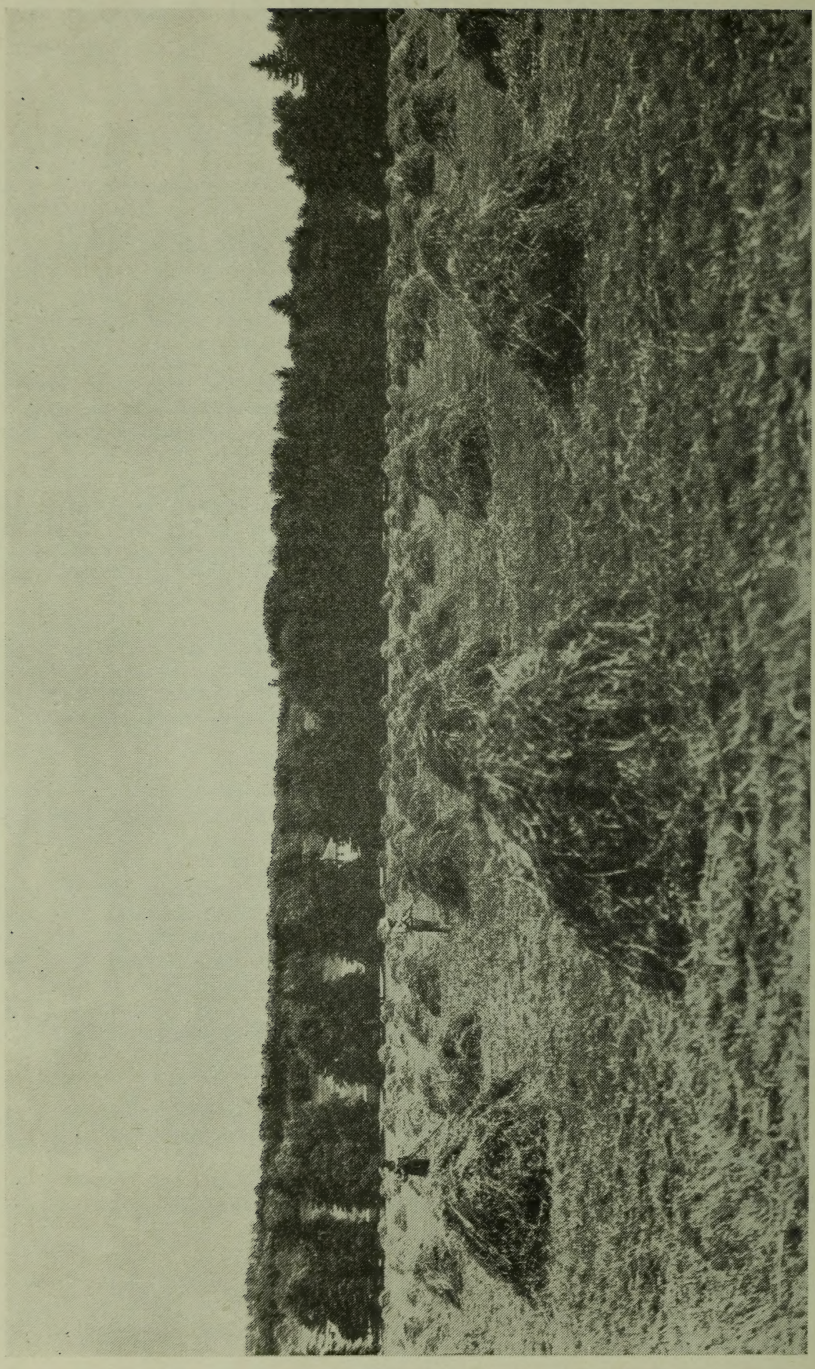

Alfalfa in coil. First cutting of the 1924 season at the Dominion Experimental Farm, Brandon.

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INTRODUCTION

Alfalfa is one of the oldest of the cultivated forage plants. Its original home was in western Asia, and from thence it has spread to practically all parts of the civilized world, exhibiting a wonderful adaptability.

While the introduction of alfalfa into Manitoba dates back to the early eighties, it has never been extensively grown. The acreage in the past decade has remained fairly constant, varying between 7,000 and 9,000 acres. The value of alfalfa as stock feed is fully appreciated. The lack of enthusiasm for this crop is due to the high price of the seed of hardy strains, and the number of failures experienced in establishing a stand. A considerable number of farmers, however, have grown alfalfa successfully. The average yield of alfalfa in the province for the past ten years is 2·29 tons of cured hay per acre as compared with 1·47 tons per acre from grass and clover mixtures.

Alfalfa has been grown successfully at the Dominion Experimental Farm at Brandon since 1887. It has outyielded all varieties of grasses and clovers by a wide margin. Even partial winter-killing has been rare, and when it has occurred, it has been directly traceable to some faulty cultural method.

In view of the good results obtained on this Farm, and the growing demand for information regarding alfalfa, this bulletin has been prepared. The data presented and the conclusions drawn are based upon experiments conducted at this Farm over a period of years, as well as upon close observation of the crop in various parts of the province. The experimental area is situated in the Assiniboine valley and the soil is a rich, clay loam. The excellent results obtained at Brandon are no doubt partly due to the favoured location.

Alfalfa may not thrive in all parts of the province, but its range of adaptability is much greater than indicated by present-day plantings. It would appear that this valuable forage plant deserves a much wider trial in Manitoba.

ALFALFA GROWN FOR HAY

Well-cured alfalfa hay is readily eaten by all classes of live stock, and is unsurpassed in palatability and feeding value. Like all legumes, it is particularly high in protein, hence its inclusion in the ration will replace to a considerable extent the amount of protein that otherwise would have to be bought

in the form of high-priced concentrates. The following figures from Henry's "Feeds and Feeding" show the relative feeding value of alfalfa hay compared with timothy hay and some of the concentrates.

TABLE 1—COMPARATIVE FEEDING VALUE OF ALFALFA

—	Total dry matter in 100 pounds	Digestible nutrients in 100 pounds			
		Crude protein	Carbo-hydrates	Fat	Total
	lb.	lb.	lb.	lb.	lb.
Alfalfa hay	91·4	10·6	39·0	0·9	51·6
Alfalfa leaves	93·4	15·8	35·1	1·3	53·8
Alfalfa stems	94·4	1·8	46·9	0·4	49·6
Timothy	88·4	3·0	42·8	1·2	48·5
Wheat bran (spring)	89·6	11·9	43·3	3·0	62·0
Oats (grain)	90·8	9·7	52·1	3·8	70·4

ALFALFA FOR PASTURE

Considerable prejudice exists against alfalfa due to the tendency of the animals to bloat when pastured on it; but alfalfa may be pastured without any ill results, if certain precautions are taken. Ruminating animals, such as cattle and sheep, are most likely to suffer from bloating, particularly if unaccustomed to this pasture and allowed to gorge themselves. Bloating is also more likely to occur if the animals are turned out to pasture when the plants are moist with dew; hence ruminating animals should be gradually accustomed to the alfalfa pasture.

Horses do well on alfalfa pasture, though it is claimed that it unduly stimulates the kidneys on account of the high protein content.

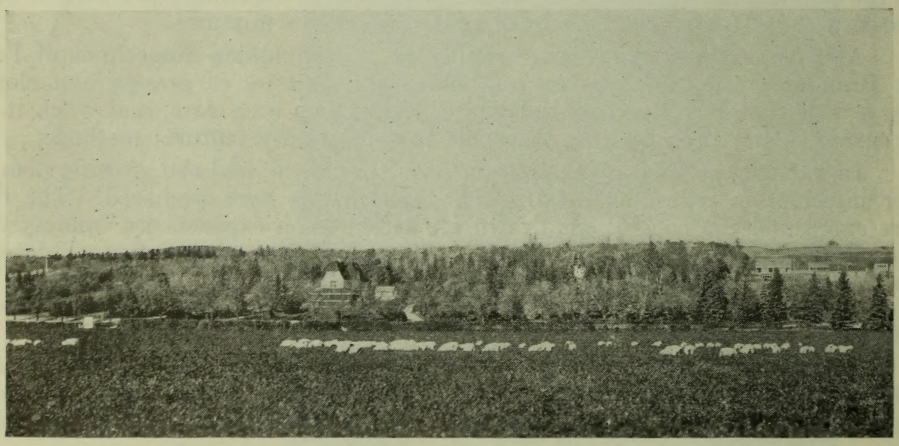

Fig. 1—Sheep pasturing on alfalfa aftermath. Two cuttings were harvested earlier in the season.

While alfalfa makes excellent pasture, close grazing at any time should be avoided. Close pasturing in the summer tends to weaken the crop, as the crowns are likely to be injured, while in the late fall it is even more injurious, as then it lessens the winter protection. Horses and sheep will do more damage than cattle in this respect.

Pasturing is distinctly detrimental in the seeding-down year, and the crop should be pastured only lightly during the second season.

COMPARING ALFALFA, SWEET CLOVER AND GRASSES

Yield and quality determine to a large extent the agricultural value of hay-producing plants. The various clovers and grasses have been grown for many years at the Dominion Experimental Farm, Brandon, under comparable conditions. The comparative yield data of some of the commonly grown types are presented in table 2.

TABLE 2—YIELDS OF ALFALFA, SWEET CLOVER AND GRASSES

Variety	Yield of cured hay per acre			
	Nine-year average 1912–24		Three-year aver ge 1922–24	
	tons	lb.	tons	lb.
Alfalfa (average of four varieties)	4	768	5	479
Sweet clover, biennial white	..	..	3	535
Brome	3	209	2	1,360
Western rye grass	2	1,628	2	1,012
Timothy	1	1,984	1	1,705

The most striking feature in the table is the high yield of alfalfa as compared with other hay crops. It has been outyielded by brome only in the driest years, but has yielded considerably higher than the other hay crops tested in years with a plentiful moisture supply.

Alfalfa has always produced two cuttings during a season, and enough aftermath for winter protection. The season 1915 was particularly favourable for alfalfa and three cuttings were harvested. This resulted in a weakened stand and partial winter-killing. A repetition of this practice in 1922 gave no ill effects. Ordinarily, it is not considered good policy to harvest three cuttings owing to the danger of winter-killing.

Sweet clover does not compare with alfalfa in yield where both crops can be grown successfully. It is, however, less exacting in regard to soil and climate, and may give a higher yield under adverse conditions. The tall, upright growth of the sweet clover is very deceiving and the yield appears to be heavier than it actually is.

Sweet clover is more woody than alfalfa and is distinctly less palatable as a hay crop. Both are, however, similar in composition and practically equal in feeding value. Farm animals discriminate against sweet clover at first when used as pasture, but soon develop a taste for it. Sweet clover has recently become very popular in Manitoba, and is at present grown on a much larger scale than alfalfa. This may be accounted for by the cheapness of the seed and the relative ease of obtaining a stand.

SOIL REQUIREMENTS

Alfalfa seems to thrive on soils varying from heavy clays to coarser-grained sandy soils, provided there is natural drainage. It does best, however, on rich loamy soils with a permeable subsoil, well supplied with moisture. Alfalfa is a deep-rooted plant, drawing much of its nourishment from the subsoil, and hence it is ill adapted to soils with an impenetrable layer or a hardpan below the surface soil. Fortunately, this condition rarely exists in the arable part of Manitoba.

Alfalfa will not thrive on water-logged soil or on land that is likely to be flooded for a part of the year. At the Brandon Farm, a field of alfalfa and mixed grasses was flooded early in the spring of 1922. The water remained on

the land for two weeks, during which time the alfalfa plants were dormant, and no ill results were noticed. The same field was again flooded in the spring of 1923, the water remaining for a longer period, and after the frost was out of the ground. The alfalfa was completely killed on the flooded portion of the field, while the stand of the various grasses was in no way impaired. This would indicate that an established alfalfa field can withstand flooding for a short time in the spring during the time that the plants are dormant, but if this period is prolonged or occurs during the growing season, the plants will usually die.

PLACE IN ROTATION

On account of the high price of seed and the value of an established field that is likely to remain productive for many years, alfalfa is not well adapted to short rotations. Long rotations are unwieldy and require careful planning. If the alfalfa is allowed to remain for some years, the percentage of the land in alfalfa becomes too high under the present system of extensive grain farming or even in mixed farming rotations. A ten-year rotation, featuring alfalfa, was in operation at the Brandon Farm from 1912 to 1922. In this rotation, exactly one-half of the land was required for alfalfa, and the sod was broken at the end of the fourth cropping year. Such a rotation is well adapted to dairy farming or where much live stock is kept.

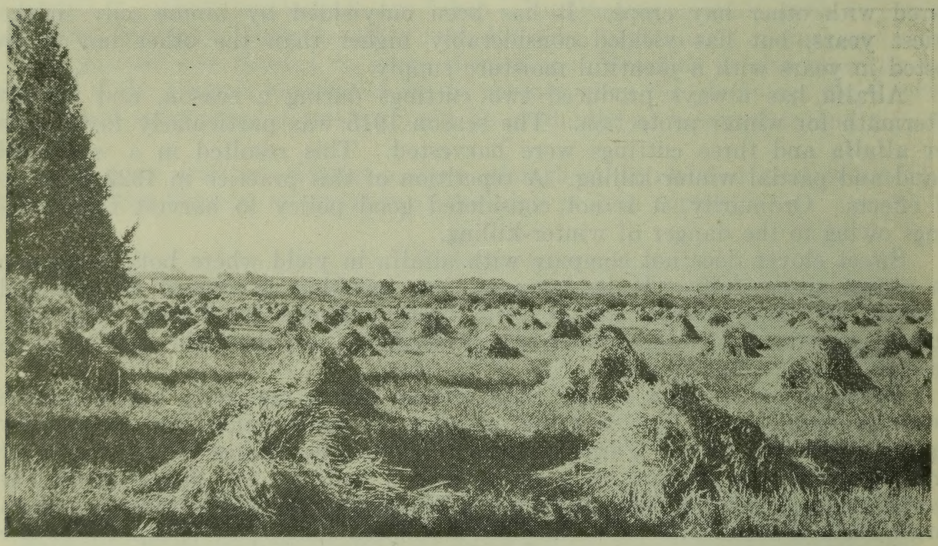

Fig. 2—Wheat following alfalfa in a crop-rotation at Brandon.

Alfalfa can, however, be successfully and economically included in a rotation of medium duration by having one more field than there are years in the rotation. In this case the alfalfa should be seeded down in the most favourable part of the rotation, preferably with a light nurse-crop of wheat and on summer-fallowed land or following an intertilled crop. The field would then remain in alfalfa until the other crops had completed one cycle of the rotation and a stand established on another field. It is not the intention here to outline a definite rotation, since the acreage of alfalfa required varies with the type of farming and all of the farm may not be suitable for alfalfa production.

The alfalfa can most profitably be followed in the rotation by some crop that is a heavy feeder on soil nitrogen and requires clean land. Alfalfa sod is usually freer from weeds than summer-fallowed land, and hence is well adapted to growing wheat.

PREPARATORY CROPS

An experiment was inaugurated at the Brandon Experimental Farm in 1912 to determine the best preparatory crops, the best cropping systems to use prior to seeding down to alfalfa, and the influence of these on the stand and the resulting hay yield. Two plots have been seeded down each year on fallow, on corn-land, on first-year stubble and on second-year stubble. The mixture used consists of 6 pounds alfalfa and 6 pounds western rye grass, with the alfalfa predominating in the resulting hay crop. A five-year rotation is followed, each set of plots being operated in a separate rotation. The results obtained are here presented in table 3.

TABLE 3.—INFLUENCE OF PRECEDING CROPS

Preceding crops	Yield of cured hay per acre, ten-year average	
	tons	lb.
Summer-fallow	2	1,752
Corn-land	2	1,564
First-year wheat stubble	2	1,165
Second-year wheat stubble	2	539

The highest yields in this experiment have been obtained by seeding down on summer-fallow and on corn-land, and a good catch has always been obtained. Good stands have also been obtained on stubble-land, but less consistently, and the yields have been slightly smaller. It must be borne in mind, however, that the land in this experiment has been relatively free from weeds. Stubble-land, in the average year, probably has the moisture requirements to produce a good stand, but is usually more or less polluted with weeds. Alfalfa is a poor " weed fighter " during its first growing season, but will keep most weeds in check when it has become well established. Seeding on weed-infested fields is responsible for numerous failures, and the certainty of obtaining a vigorous catch depends largely on how far the seeding-down year is removed from the fallow. While satisfactory yields may be expected by seeding down on clean stubble-land, the advisability of this practice depends entirely on the degree and kind of weed infestation. In view of the larger number of weed seeds, smaller yields, and occasional failures when stubble-land is used, seeding on fallow or corn-land is recommended.

SEED-BED PREPARATION

The success of alfalfa the first season depends to a large extent on the surface soil, and the preparation of the seed-bed, just as the success in later years depends largely on the nature of the subsoil and its permeability.

The preparation of the soil for alfalfa should begin with the preceding crop, the object being to get the land well settled, free from weeds and well supplied with moisture at seeding time. Spring-ploughed land is less satisfactory than fall-ploughed land on account of the loose condition of the seed-bed, but may be used if ploughed early and some means adopted of firming the soil, which brings the moisture closer to the surface and permits of shallower seeding. On land ploughed the previous season, spring cultivation is beneficial as it warms and aerates the soil, and hastens bacterial activity. Deep cultivation, however, is unnecessary, and may in fact be detrimental, producing too loose a seed-bed.

VARIETIES

One of the most important factors in successful alfalfa growing in Manitoba is the use of northern-grown seed of the hardy varieties. Relatively non-hardy varieties may in some years give a good yield but are likely to be partially winter-killed in other years. In view of the high price of the seed, and the value of an established field of alfalfa, failures should be guarded against by the use of hardy varieties.

There are three commonly recognized species of alfalfa under cultivation. The purple-flowered alfalfa (*Medicago sativa*) constitutes a separate group of which there are numerous varieties. These are tall-growing, usually have small crowns and are relatively non-hardy.

The yellow-flowered sickle alfalfa (*Medicago falcata*) ranges in habit of growth from prostrate to erect. The chief value of this species lies in its hardiness and its ability to withstand severe climatic conditions.

Varieties of these species readily intercross when grown in close proximity. This has given rise to the group of variegated alfalfa (*Medicago media*). This group is characterized by a great diversity in colour of flower, ranging from purple to yellow, and having various intermediate shades, including creamy-white and smoky hues.

The variegated group of alfalfa is considered relatively winter-hardy, which characteristic it no doubt owes to its hybrid origin. Most of the northern-grown varieties belong to this group, and are very similar in appearance. The varietal names usually indicate their geographic origin or that they have been grown for a number of years in a certain country or in a certain section of that country rather than any distinction in botanical characters. These varieties, however, may differ in their physiological characters and their ability to withstand severe climatic conditions. When a variety is grown for a number of years in the same place, natural selection takes place. There is a gradual elimination of the weakest strains and the fittest survive.

Variety tests with alfalfa have been conducted at the Brandon Experimental Farm for many years. It is not possible to give comparable results of all the varieties for a period of years since some of them have been dropped from the test intermittently on account of seed not being procurable. The yield data of a few of the well-known varieties are presented in table 4.

TABLE 4—VARIETY TEST

Name of Variety	Yield of cured hay per acre			
	Three-year average		Eight-year average	
	tons	lb.	tons	lb.
Baltic	5	1,049	..	..
Grimm	5	248	3	1,012
Macsel	5	177	..	..
Montana	5	4	3	282
Disco 38	4	1,888	..	..
Liscomb	4	1,727	3	143
Turkestan	4	1,344	3	321
Manitoba	3	1,997	..	..

Grimm alfalfa belongs to the variegated group. The original seed was brought to Minnesota in 1857 by Wendelin Grimm, a German farmer. Since that time, this variety has undergone selective acclimatization and has acquired a wide reputation on account of its ability to endure cold.

Grimm and Turkestan alfalfa have been grown on this Farm for many years and are known to be hardy and reliable. During the past fifteen years, under plot conditions, Grimm has given an average yield of 4 tons 318 pounds of cured hay per acre, while Turkestan has yielded 3 tons 1,408 pounds per acre under similar conditions. Both of these varieties are characterized by broad, deep-set crowns and a large root-system having numerous branches. Turkestan belongs to the purple-flowered group, but appears to have a better developed root-system than other varieties in that group.

Baltic is a variegated variety and appears to be similar to Grimm in all respects. The exact origin is not known. It received this varietal name in 1906 for the reason that it had been grown near Baltic, South Dakota, for many years. During the eight years that Baltic has been included in the varietal tests at Brandon, it has outyielded Grimm by approximately one-quarter of a ton per acre and has shown no signs of winter-killing. The seed of Grimm alfalfa has acquired such a reputation that the supply has not been equal to the demand. For this reason it has usually been sold at a considerable premium over other varieties. The results at Brandon have shown that Grimm and Baltic are at least equal in agricultural value and that either variety is suitable for Manitoba conditions.

Cossack was originated by Prof. N. E. Hansen of the South Dakota Agricultural College. It is a selection from a single plant which was growing wild on the dry steppes of Russia and belongs to the variegated type. Cossack has slightly surpassed the well-known variety Grimm in point of yield in a six-year test at Brandon and appears to be perfectly winter-hardy.

Canadian variegated, Liscomb and Montana have given satisfactory results though not quite equal to Grimm. The variety Montana has sometimes been slightly thinned out by winter-killing.

Common alfalfa has shown the greatest variation in hardiness of the varieties tested. In purchasing the seed, it is highly desirable that the source be known to avoid securing non-hardy seed of southern origin.

Macsel is a new variegated variety originated by Professor Southworth of the Manitoba Agricultural College. This variety is winter-hardy, and in yield of forage it compares very favourably with Grimm. Macsel is claimed to be a heavier seed-producer than other variegated varieties, and some excellent yields have been obtained in this province. No test of its seed-producing qualities has been made at Brandon.

INOCULATION

Alfalfa, like all other leguminous plants, uses a large amount of nitrogen in its growth, and as the crop yields heavily, one might expect that the available nitrogen supply in the soil would soon become exhausted. The inexhaustible supply of nitrogen contained in the air cannot be utilized by plants other than the legumes. Alfalfa belongs to the legume family, and is able to make use of this free nitrogen through the aid of certain bacteria that live and multiply in nodules or swellings on the rootlets, and draw freely upon the carbonaceous material of the plant for their own use. They also extract free nitrogen from the soil air, incorporate it in their own bodies, forming highly complex nitrogenous compounds which are directly available to the plants. Thus it will be seen that the benefits derived from this partnership are mutual, and that the relation is not that of host and parasite.

The exact metabolic process is not yet fully understood, but it is an established fact that without the aid of these bacteria, alfalfa is unable to flourish and produce good crops. Although the plants may be able to live for

some time without the aid of these bacteria, they lack stamina and vigour, and soon lose their normal green colour due to nitrogen starvation. A field such as this will prove non-productive.

Each of the leguminous crops appears to require bacteria peculiarly suited to itself, though some of the bacteria are able to adapt themselves and live upon two or more species of leguminous plants. For instance the bacteria living upon the sweet clover roots are also able to live upon alfalfa roots; hence planting sweet clover is an excellent preparation for alfalfa in districts where alfalfa has not been grown before.

The bacteria living in conjunction with alfalfa may or may not be present in native soils, but they are seldom present in large enough numbers for best results, and hense it is necessary to introduce them artificially. This may be done either by inoculating the seed with the pure culture of the bacteria or by applying soil from an old alfalfa field to seed which has been previously treated with a five per cent solution of furniture glue.

Satisfactory inoculation may also be accomplished by broadcasting, previous to seeding down, soil obtained from the top five or six inches of an old alfalfa field. The rate of application is 100 to 200 pounds per acre. This method gives good results but has the disadvantage that it requires considerable labour, and it may be the means of introducing foul weeds that have not hitherto been present on the farm.

Applying the pure culture is now the generally adopted method. This culture may be obtained free of charge from the Division of Bacteriology, Central Experimental Farm, Ottawa, or may be bought very cheaply at the Manitoba Agricultural College, St. Vital. When applying for the culture, the quantity and kind of seed to be treated should be stated. Directions for applying are sent with the culture.

DATE OF SEEDING

Late seeding is the direct cause of many failures in obtaining a good catch of alfalfa, as the seed is then altogether dependent on timely rainfall for germination. The time of seeding is of comparatively little importance in favourable seasons, but in normal years late seeding is too risky, and it is advisable to seed early enough to make use of the moisture from the melted snow.

Alfalfa appears to be more frost-hardy than is commonly supposed. In the spring of 1924, at the Brandon Experimental Farm, alfalfa was sown with a nurse-crop of wheat at intervals of ten days ranging from April 30 to June 20. Several quite sharp frosts occurred at different times throughout the month of May after the alfalfa had germinated. No ill results were recorded. An actual count of the number of plants per square foot was made after the wheat was harvested, and in each case the number of plants per unit area was in direct proportion to the earliness of seeding.

A summary of a recent experiment in dates of seeding alfalfa is given in table 5. In this test the alfalfa was sown without a nurse-crop.

Table 5—Date of Seeding Test

Date of Seeding	Yield of cured hay per acre							
	1922		1923		1924		Three-year average	
	tons	lb.	tons	lb.	tons	lb.	tons	lb.
Sown May 5	4	760	3	1,380	2	360	3	833
Sown May 15	4	1,960	4	160	1	1,960	3	1,360
Sown May 25	3	800	3	1,040	1	1,520	2	1,787
Sown June 5	3	1,240	3	1,120	2	..	3	120
Sown June 15	2	1,080	2	40	1	1,360	2	160

It will be noticed that the May 15 seeding has given an average yield of approximately 1½ tons more per acre than the June 15 seeding. In the seeding-down year, 1921, there was considerable moisture during the month of May, but the continued midsummer drought made conditions very unfavourable for the late seeding. The late-sown plots looked like a complete failure at harvest, but were revived by the copious fall rains and produced a fair crop in 1922. It is worthy of note that the plots have continued to yield in practically the same ratio as in 1922, which would indicate that in succeeding years, the yield is in direct proportion to the stand obtained the first season.

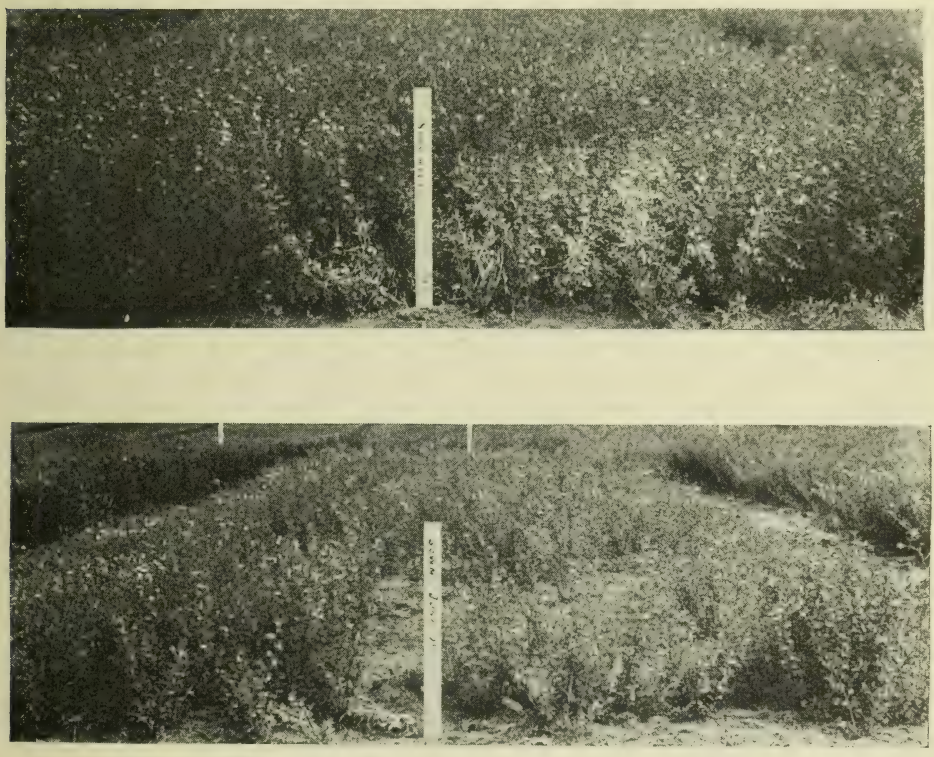

Fig. 3—The plot of alfalfa in the upper picture was sown on May 15 of the previous year; the plot in the lower picture was sown one month later. Note the weak stand from the late seeding.

Since alfalfa is comparatively frost-hardy, it would seem safe to sow it as early in the spring as it is advisable to sow the nurse-crop. The date could vary with the kind of nurse-crop used.

RATES OF SEEDING

Experiments in rates of seeding alfalfa have been conducted since 1916, the rates tested varying from 5 pounds per acre to 20 pounds per acre. More recently, the heavier rates of seeding have been dropped.

TABLE 6—RATES FOR SEEDING ALFALFA

Rate of Seeding	Yield of cured hay per acre					
	Four-year average 1916, 1917, 1920 and 1921		Three-year average 1922–24		Seven-year average	
	tons	lb.	tons	lb.	tons	lb.
Alfalfa, 5 lb. per acre	..	..	2	1,752	..	..
" 7½ "	3	330	2	1,817	3	224
" 10 "	3	1,003	2	1,770	3	387
" 12½ "	3	563	2	1,726	3	145
" 15 "	3	803	2	1,576	3	190
" 17½ "	3	43	..	..	..	..
" 20 "	3	133	..	..	..	..

The maximum yields of hay have been obtained by seeding 7½ to 10 pounds per acre, and the heavier rates of seeding have actually decreased the yield. This would indicate that the ordinary rates of seeding alfalfa are unnecessarily high, and that a good quantity of seed might well be saved without any lowering of the yield. The catch obtained depends more on seed-bed preparation and soil conditions, than on the actual amount of seed sown. If all grew and were evenly distributed, an excellent stand could be obtained from less than one pound per acre of good, germinable alfalfa seed. Since ideal conditions do not exist in the field, a heavier rate of seeding must be adopted. It is worthy of note that good stands have been obtained by seeding as little as 5 pounds per acre on a well-prepared seed-bed, but it is safer and more practical to increase the rate of seeding to 8 or 10 pounds per acre. Anything over that amount appears to be a waste of seed. A slightly heavier rate of seeding should be practised when a nurse-crop is used, in order to partially overcome the handicap that the plants are placed under.

It has been noticed that during prolonged periods of drouth, the heavy rates of seeding alfalfa have invariably suffered the most. Two to three plants per square foot represents a good stand. These plants will tiller extensively and yield as well as twice that number in normal seasons. Too many plants per unit area are likely to have a detrimental effect on the longevity and the yielding capacity of the field.

METHODS OF SEEDING

In view of the high price of seed, the problem that confronts every alfalfa grower is to obtain a good stand from the minimum amount of seed. Methods of seeding have a direct bearing on the economical use of seed.

The ordinary grain drill, without a seeder attachment, can be satisfactorily used for seeding alfalfa, whether sown alone or with a nurse-crop. The alfalfa seed, when mixed with the grain, has a tendency to settle near the bottom of the grain box, resulting in uneven seeding; hence it is necessary to keep the seed well stirred. It is easier to keep the seed well stirred if the grain box is only half filled. If these precautions are taken, a uniform stand of alfalfa may be obtained when wheat is used as a nurse-crop. Less uniform distribution of the alfalfa seed is

secured when oats or barley are used as nurse crops on account of the size and shape of the kernels and the consequent greater tendency of the alfalfa to settle in the mixture.

Alfalfa, when mixed with the grain to be used as nurse-crop, does not materially increase the bulk, as it occupies to a large extent the air spaces between the kernels. If it is desired to sow 10 pounds of alfalfa seed per acre with a nurse-crop of one bushel of wheat, the alfalfa and wheat should be mixed in this proportion, and the drill, if calibrated in pounds, set to sow very little, if any more than one bushel of wheat per acre. Most drills are calibrated in quarter bushels only, and increasing the rate of seeding by one notch in order to allow for the extra bulk caused by the alfalfa seed in the mixture, would constitute a greater error than if no allowance were made.

When alfalfa is sown without a nurse-crop from an ordinary grain drill, it is necessary to increase its bulk with some inert material such as coarsely cracked wheat or barley. The floury particles should be screened out and the coarse material mixed with the alfalfa in a definite ratio such as 3 to 1 or 4 to 1 by weight. It is also advisable to remove the large particles. The rate of flow of the cracked wheat varies with the size of the particles, and usually goes through the drill just a little faster than the whole grain, hence no definite rule can be formulated as to the correct way of setting the drill. A reasonably accurate way is to set the drill at ½ bushel of wheat, jack up one wheel, and turn a certain number of revolutions by hand. The acreage covered may be computed from the wheel revolutions, and by weighing the material that has gone through, the rate of flow may be determined. Supposing that the cracked wheat goes through at the rate of 35 pounds per acre, when the drill is set to sow ½ bushel of wheat, and that it is desired to sow alfalfa at the rate of 10 pounds per acre, this amount of alfalfa should be mixed with a little less than 35 pounds of wheat in order to obtain the ratio of 1 to 3. Thus, a rate of seeding may be adopted which is sufficiently accurate for all practical purposes.

It is preferable to use a seeder attachment on the grain drill, though by no means necessary. The seeder attachment may broadcast the seed in front of the dics, or may have spouts leading into the furrow opened up by the dics. The former method results in comparatively shallow seeding, as the chains are the only means of covering the seed. Optimum conditions of moisture would be necessary for germination. The second method on the whole is preferable, as a portion of the seeds go deeper, yet not too deep, and moisture for germination is ensured.

At the Brandon Farm in recent years, the grass-seeder attachment has been used for sowing alfalfa on the large fields, while the ordinary drill has been used for seeding the 1/40 acre plots. The standard rate of seeding in each case is 10 pounds per acre. The stand on the large fields has usually been a little heavier than on the plots from the same rate of seeding.

The nature of the alfalfa plant is such that a heavy stand may be detrimental and actually reduce the yield. In the experiments to determine the best rate to sow alfalfa, as many as 8 to 10 plants per square foot have been obtained from the extra heavy seeding. Invariably the heavy stands have proven less productive than the moderately thick stands, especially in dry years. Two to three plants per square foot is considered a good stand. These more widely spaced plants will tiller according to the amount of moisture and plant food available in the soil, and a heavier yield will be obtained on the average than from the thicker growth.

SEEDING WITH NURSE-CROPS AND WITHOUT

In recent years good stands of alfalfa have always been obtained on the Brandon Farm from seeding either with or without a nurse-crop. Seeding alone

has, on the average, given a slightly greater yield in the year after seeding than where a nurse-crop was used. The decrease in yield in the first cropping season when a nurse-crop is used is partly due to the diminished water supply in the soil and is partly due to the fact that the alfalfa plants do not develop as large a root-system as when seeded alone. The difference in yield, however, in the following and succeeding cropping seasons is much less pronounced as all plants are then equally dependent on the season's moisture supply. The increased yield of hay due to seeding alone has seldom been sufficient to warrant the loss of a nurse-crop and to pay for the extra expense involved.

Seeding alone, though less economical, usually ensures a good stand. The individual plants develop a larger root-system during the seeding-down season than when a nurse-crop is used, and consequently are a little more winter-hardy. This method is recommended for beginners and on small areas when a good stand is imperative, in which case clean land must be used. Until alfalfa has become well established it is unable to thrive in competition with weeds. Seeding down on weed-infested fields may result in failure, as the weeds act as a "robber crop", depriving the young plantlets of sunlight, food and moisture. A nurse-crop is at all times preferable to a crop of weeds and is recommended in those districts having a reasonable moisture supply.

In view of the good results obtained by seeding down with a nurse-crop on this Farm, it became incumbent to determine the best nurse-crop to use. A series of plots was seeded down in the spring of 1921 to compare four types of nurse-crop with the practice of seeding alone. The alfalfa in each case was sown at the rate of 10 pounds per acre, while the nurse-crops were sown at the same rate as when sown for grain alone. The average results for two years are shown in table 7.

TABLE 7—SEEDING WITH AND WITHOUT NURSE-CROP

Nurse crop used	Rate of seeding nurse crop in 1921	Average yield of cured hay per acre, 1922 and 1923	
	bush.	tons	lb.
Sown alone	..	3	960
Sown with wheat	1½	3	160
Sown with oats	2½	2	1,620
Sown with flax	½	3	1,140
Sown with barley	2	2	500

Under favourable conditions flax gives good results as a nurse-crop, as it allows the maximum amount of sunlight to reach the plants, but it cannot compete successfully with weeds. It should only be used when seeding down on clean land. The short stubble and the late cutting of the crop are other drawbacks in using flax as a nurse-crop, because less winter protection is afforded.

Of the cereal crops tested as a nurse-crop, wheat has been the most satisfactory. It is less likely to lodge than either oats or barley and the leaves shrivel up earlier in the season allowing the tender alfalfa plants to receive more sunlight.

Good stands of alfalfa have repeatedly been obtained on this Farm, under field conditions, by using either oats or barley as a nurse-crop, but less consistently than when wheat has been used. There is considerable danger of oats and barley lodging when sown on heavy land, in which case the stand of alfalfa is likely to be patchy. Oats and barley have wider leaves than wheat, and the leaves often remain green until harvest. The result is that the alfalfa plants are

very small at harvest time, but will make considerable growth during the fall if conditions are favourable. When the seeding season is unduly delayed, so that the wheat might be considerably affected by frost or rust, it would be better to use either oats or barley as a nurse-crop.

RATES OF SEEDING NURSE-CROP

A common error in using a nurse-crop is to seed too heavily. Heavy seeding not only exhausts the moisture supply of the soil sooner than thin seeding, but the thick stand shades the young alfalfa plants more. The result is a weakened, though not necessarily a patchy stand.

An experiment has been conducted during the past three years to ascertain the best rate for seeding wheat used as a nurse-crop with sweet clover. The rate of seeding wheat has varied from $\frac{3}{4}$ to $2\frac{1}{4}$ bushels per acre, the rate of seeding the clover being constant in each case. Invariably the vigour of stand, and the height of the clover plants the first season, has been in direct proportion to the thinness of seeding the nurse-crop. Moreover, the yield of the nurse-crop from the different rates of seeding has varied within very narrow limits. The extra heavy seeding has not increased the yield of wheat, while the maximum yield has been obtained from the medium rates of seeding. Alfalfa grows less vigorously in the seeding-down season than sweet clover, hence a somewhat thinner rate for seeding the nurse-crop should be practised. The cost of the seed, and the importance of obtaining a good catch would justify this practice, even at the expense of a lowered yield of the nurse-crop. Ordinarily, a bushel of wheat per acre should be quite sufficient. The standard rate of seeding other cereals should be lowered to a similar extent when they are used as nurse-crops for alfalfa.

In the spring of 1924, experiments were begun to test the different rates of seeding wheat and barley when used as nurse-crops for alfalfa. At harvest time the height of the alfalfa plants varied from 2 to 3 inches in the thick seeding to fully 12 inches in the thin seeding. The vigour of stand in the seeding-down season has, as already pointed out, a direct influence on the yield obtained in the first cropping season hence the importance of getting the plants well established the first year.

TREATMENT FOLLOWING SEEDING

The seeding-down season is a critical time in the life of the alfalfa plant. The uniformity and vigour of stand then obtained have a direct bearing on the yield in subsequent years.

When sown without a nurse-crop it is usually necessary to mow the field once or twice during the seeding-down season to prevent the weeds from forming seeds. Even if no weeds are present, this practice is commendable, as it encourages root development, and therefore renders the plants more winter-hardy. Under favourable conditions, the crop may reach the blossom stage during the seeding-down season, but harvesting the crop for hay would give detrimental after results. It is advisable to mow the field once or twice during the summer, irrespective of the absence of weeds. The clippings are usually left on the ground as a mulch. The last cutting should be done early enough in the season, to allow the plants to go into the winter with a growth of at least eight inches. This will catch the drifting snow and afford winter protection.

When a nurse-crop lodges and is allowed to lie, the alfalfa plants are greatly weakened; so it may be advisable to harvest the lodged nurse-crop as hay. In harvesting the grain crop, it is best to leave the stubble high. Stooks allowed to remain on the same spot for several weeks are likely to smother the alfalfa.

For this reason, it is advisable to thresh the nurse crop as soon as possible after harvest, otherwise it may be necessary to shift the stooks.

Pasturing alfalfa the first season is not advisable whether sown with or without a nurse-crop.

WHEN TO CUT

It is generally believed that the best time to cut alfalfa is when the new shoots appear from the crown, and before they are high enough to be clipped off by the mower. When cutting is delayed until the basal shoots are 3 or 4 inches high, it is claimed that two crops are cut and but one harvested.

Professor L. F. Graber of the Wisconsin Agricultural College has conducted extensive experiments to determine the best time to cut alfalfa. Regarding early cutting, his findings are in agreement with those of other investigators, which are that early cutting weakens the root system of the crop and lowers the yielding capacity of the field. On the other hand, no ill effects are reported from clipping the basal shoots, and cutting in full bloom gave the best results. Later cutting than this is not recommended, as at this stage the crop commences to become woody and the yield of the second cutting may be lowered.

The basal shoots usually appear when the crop is one-tenth to one-third in bloom, varying with the kind of season. A wet season retards the bloom, and conversely, the basal shoots are slow in appearing in dry weather. The appearance of basal shoots, therefore, is not a safe guide to follow, and it is advisable to commence cutting just before the crop reaches full bloom.

CURING ALFALFA HAY

Alfalfa hay is rather difficult to cure on account of its high moisture content and heavy yield. It differs from the grasses, in that the leaves are easily lost, and the leaves contain the major portion of the most desirable nutriment of alfalfa hay. In feeding value, alfalfa leaves are equal to wheat bran, ton for ton. According to actual determinations made on this Farm, alfalfa leaves constitute approximately 45 per cent of the crop, green weight, when cut in medium bloom. Thus the importance of saving a large proportion

Fig. 4—Turning alfalfa coils before drawing to the barn in order to dry out the moisture at the base.

of the leaves will readily be seen. If alfalfa is cured in the swath the leaves will shrivel and fall off before the moisture is out of the stems. This loss can be partially overcome by the use of a tedder which will allow free circulation of air through the swath or windrow without exposing too many of the leaves to the direct rays of the sun.

In wet weather, most of the curing should be done in small coils. Large coils become air-tight and discolour the hay instead of curing it. The hay near the bottom of the coil will absorb moisture from the ground, hence it is advisable to invert the coils for a few hours drying before stacking or storing the hay. When curing takes place in the coil, the hay is raked fairly green. The time required for curing depends on the size of the coils. Four to six days of good drying weather are usually necessary. This method of curing is not entirely satisfactory, as the outer portion of the coils becomes discoloured, and if the hay is exposed to unfavourable weather for several days, the resulting loss is likely to be even greater than would result from shattering under more rapid curing methods.

The method of curing depends on the weather conditions. If the weather is favourable, it may be advisable to hasten the process by doing much of the curing in the windrow, even at a sacrifice of some of the leaves, but in unfavourable weather the only alternative is curing the hay in small coils. Rains not only discolour, and lessen the palatability and digestibility of the crop, but will remove in solution a part of the nutritious portion of the fodder.

When judging as to the fitness for storing, the stems rather than the leaves should be observed. The leaves may be shrivelled and ready to fall off on the slightest provocation, and the stems full of moisture at the same time. The hay is considered fit for storing when no moisture can be squeezed out of the stems.

Alfalfa hay should not be drawn to the stack or mow when the dew is on the ground, even if the hay appears to be dry. External moisture is much more harmful than the same amount of internal moisture, and is apt to cause overheating in the mow.

TREATMENT AFTER TWO-YEARS' CROPPING

Disking an alfalfa field in the early spring, after cropping for two years, is beneficial and will invigorate the crop, destroying weeds and aerating the soil. If the disk harrow is not set at too great an angle, this practice will not damage the crop.

The duck-foot cultivator, with the narrow teeth, has also been used for this purpose at the Brandon Farm. The drag-harrow follows this operation, and while the field may appear destroyed, no ill results have been recorded.

METHODS OF BREAKING ALFALFA SOD

Various methods of breaking sod have been tested for more than a decade. The sod used for experimental purposes has been obtained by seeding down each year a mixture of western rye grass, red clover and alfalfa. In each case the land has been broken up during the third cropping season, at which time the alfalfa has formed the major portion of the mixture. Wheat has been sown on all plots the following year and the yields, thoroughness of the rotting of the

sod, and persistency of the grass and alfalfa recorded. The average results for eleven years are given in table 8.

TABLE 8—METHODS OF BREAKING ALFALFA SOD

Treatment given	Yield of wheat per acre in test year	
	bush.	lb.
Plough in July, 5 inches deep as soon as crop is removed	27	43
Plough in October, 5 inches deep	28	7
Plough in July, 5 inches deep, as soon as crop is removed; backset 5 inches deep in September	34	7
Plough in May; work as summer-fallow	38	41

If alfalfa sod is ploughed in the spring, and treated as summer-fallow, two ploughings are invariably necessary to completely eradicate the alfalfa. If, on the other hand, one crop of hay is harvested, and the sod broken immediately afterwards, at which time the roots are partially exhausted and the plants are in their weakest condition, one ploughing, with suitable subsequent cultivation, is usually sufficient. This constitutes a partial summer-fallow, and in reasonably moist districts leaves the sod sufficiently well rotted to receive a grain crop the following season, and supply the plant food and moisture necessary for good growth. The complete fallow has produced a heavier yield of wheat, but has done so less economically, and the increased yield has not been nearly sufficient to compensate for the loss of the hay crop.

Backsetting in September has given a sufficiently increased yield to pay for the extra work and has been more effective in destroying the alfalfa.

Breaking sod in October is a poor practice as it is difficult to get the land in good seed-bed shape and to destroy all vegetation. It would be better to sacrifice the second cutting and break earlier in the season.

Early spring breaking, sown to a grain crop the same season, has produced similar results.

The woody nature of the alfalfa roots makes ploughing extremely difficult, and the older the field, the more power is necessary for breaking the sod. The dryness of the soil also increases the difficulty of ploughing. In Manitoba, alfalfa fields are usually ploughed up at the end of the third or fourth cropping seasons, at which time ploughing is comparatively easy if good sharp shares are used.

SEED PRODUCTION

The present cost of northern-grown, hardy alfalfa seed is a serious obstacle in the way of alfalfa production. So far, very little seed has been produced in Manitoba, and seed production has been tried only in an experimental way. Profitable yields have been obtained in different sections of the country, though only in some years. In 1914, an eight-acre field at Neepawa, Manitoba, produced Grimm alfalfa seed at the rate of 300 pounds per acre. The variety, Macsel, has been tried in the Selkirk district since 1921. One farmer in 1922 reported a yield of 600 pounds of seed per acre and over 300 pounds in 1923.

Failures and unprofitable yields of alfalfa seed have also been experienced. These have occurred chiefly in wet seasons. The season has considerable influence on the seed crop, and wet weather and rank luxuriant growth at the time of blossoming are unfavourable for seed production. In general, those conditions which produce a heavy yield of forage result in poor seed setting.

Most of the seed of the hardy strains of alfalfa used in Manitoba is grown in the northern States under very similar climatic conditions to those of that

province. The most profitable seed crops are obtained in the dry years. For this reason it would seem that the drier districts of Manitoba might be well suited to alfalfa seed production. In view of occasional good yields obtained in the past, the possibilities of profitable seed production in Manitoba should be investigated further.

A thin stand is the chief requisite for profitable seed production. Isolated alfalfa plants set seed more heavily than those growing in competition with their neighbours. Similarly, if the individual plants in the field are given plenty of room to develop, a larger seed crop may be expected. When the crop is intended for seed, it is customary to sow the alfalfa in rows and to intertill. Sown in this way the plants will present a semi-spherical mass of blossoms to the sunlight, and will have a larger number of blossoms per unit area than when the crop is sown thickly.

MIXTURES OF ALFALFA AND GRASSES

In order to determine the value of the different grasses when grown in combination with alfalfa, a series of plots was seeded down in the spring of 1921. The plots were sown without nurse-crops. In each mixture the alfalfa was sown at the rate of 6 pounds per acre, which is one-half the usual rate adopted when seeded alone. The grasses were sown at one-half or one-quarter the

Fig. 5—The mixture in the plot to the left is alfalfa and brome grass, and that on the right is alfalfa and western rye grass. Note the aggressiveness of the brome grass.

standard rate, according to whether one kind or two kinds of grass were included in the mixture. These rates were chosen in order to harvest a crop consisting of equal proportions of alfalfa and grass. The grasses, however, with the exception of brome, proved the less aggressive and the alfalfa predominated in the mixtures. This condition can be overcome to a certain extent by increasing the relative rate of seeding of the least aggressive grasses.

Table 9—Alfalfa Seeded With Grasses

Mixture	Rate of seeding, 1921	Proportion of crops in stand, 1924	Yield of cured hay per acre	
			1924	Three-year average
	lb.	per cent	tons lb.	tons lb.
Alfalfa, timothy and western rye	6, 2, 4	70, 25, 5	2 1,937	4 1,312
Alfalfa, brome and western rye	6, 3, 3	50, 50, 0	2 1,971	4 817
Alfalfa and western rye	6, 6	80, 20	2 214	3 1,578
Alfalfa and meadow fescue	6, 6	45, 55	2 878	3 1,359
Alfalfa and brome	6, 6	30, 70	2 515	3 838
Alfalfa and timothy	6, 4	70, 30	2 312	3 451

Alfalfa and western rye grass make a good mixture. Neither one overcrowds the other during the first two cropping seasons. After that time the western rye usually becomes non-productive, even when sown alone. When sown in equal proportions by weight, the alfalfa slightly predominates in the first cutting, while the second cutting is almost wholly alfalfa. This is also true of other grasses, since they produce only one cutting during the season.

Meadow fescue is somewhat less suitable in a mixture than is western rye on account of the uncertainty of obtaining a catch. On the other hand, the fescue will last longer in the mixture. It has moderately aggressive underground stems which will help to thicken the stand. It will be noted in the above experiment that the meadow fescue held more than its proportion of the mixture in the third cropping season, 1924, while the percentage of western rye was very small. The percentage of these grasses in the mixtures was practically reversed in the first year after seeding down.

Timothy, when sown with alfalfa, adds to the palatability of the mixture and the ease of curing. It is, however, much more difficult to obtain a vigorous stand with timothy than with western rye grass, but once established it holds the original proportion of the mixture fairly well for two or three years after seeding down. Timothy does best in moist districts. Since a stand of timothy is not certain, it would be advisable to include with it in the mixture another grass such as western rye.

Brome, on account of its persistency and spreading habit, is too aggressive to sow with alfalfa, when both are sown at the same rate per acre. Alfalfa is crowded out by the brome in the first cropping season and does not subsequently get a chance to recover. In this connection it is interesting to note in the table that the plot sown to alfalfa, brome and western rye has given a higher average yield than the plot sown to alfalfa and brome. In the former case the western rye, being the least aggressive, constituted only a small portion of the mixture in the first two cropping seasons and had totally disappeared in the following year, 1924. (See table 9.) The mixture used was in reality equivalent to seeding 6 pounds of alfalfa and 3 pounds of brome per acre. The stand of brome gradually thickened and in the third cropping season the brome constituted fully 50 per cent of the mixture. On the second plot, the original seeding of brome was too heavy, with the result that the mixture consisted of only 30 per cent alfalfa. When alfalfa and brome are sown together, it would seem advisable to adopt a lower rate for seeding brome, or to include along with it in the mixture a short-lived grass such as western rye.

ALFALFA IN INTERTILLED ROWS

Seeding alfalfa in rows so spaced as to allow of intertillage is a practice that has gained some popularity in the drier areas of the West. The intertillage affords an effective means of combatting weeds and conserves moisture.

Owing to the favourable results obtained in the drier areas, it was thought advisable to test this method under Manitoba conditions. The alfalfa was sown in rows separated by distances varying from 12 to 42 inches. The seed was sown

with the ordinary grain drill, the intervening spouts being closed. The average results for the years 1922 and 1923 are given in table 10:—

Table 10—Alfalfa Sown in Intertilled Rows

Distance between rows	Yield of cured hay per acre, two-year average	
	tons.	lb
Sown in rows 12 inches apart	4	1,360
" 24 "	3	1,909
" 30 "	4	1,066
" 36 "	4	854
" 42 "	4	388
Sown in rows, average of 5 plots	4	715
Sown in 6-inch drills, average of 2 plots	4	1,935

The yield of alfalfa sown in rows, at varying distances apart, has been remarkably high. Though no direct comparison is possible, the row method compares favourably in point of yield with that of the ordinary method of seeding on similar and adjoining land.

While the row method appears to be advantageous during the seeding-down season, it has several disadvantages in succeeding years and cannot be recommended where ordinary seeding is successful, and the crop is to be cut for hay. Seeding in rows increases the difficulty of harvesting the crop. The uneveness of the ground causes the mower to travel with a jerky motion and the crop has a greater tendency to lodge than when sown in 6-inch drills. Raking and tedding raises the dust and a dusty crop is harvested. Very little intertillage is possible after the seeding-down year, as the alfalfa grows luxuriantly, and at cutting time the rows are hardly discernible, even when placed three feet apart.

Where moisture is the chief requisite in profitable crop production, the row method may be advantageous.

SUMMARY

1. The acreage of alfalfa in Manitoba is comparatively small. This is chiefly due to the high price of northern-grown seed of hardy strains.

2. Though some have experienced difficulty in establishing a stand, alfalfa has been grown with a fair degree of success in Manitoba, and it value as stock feed and as a soil improver is fully appreciated.

3. Alfalfa has consistently outyielded all other hay crops on this Farm, and is surpassed by none in quality or in feeding value.

4. Essentials in obtaining a stand are:
   (1) Using northern-grown, viable seed of hardy strains of alfalfa.
   (2) Inoculation of the seed.
   (3) Comparatively early and shallow seeding.
   (4) Clean, firm, moist seed-bed with a permeable subsoil and natural drainage.

5. Grimm and Baltic are the varieties recommended. The latter is equally hardy and productive, and the seed is less expensive.

6. Seeding alfalfa with a nurse-crop gives practically as good results as seeding alone, and the crop is much more economically grown.

7. Wheat is more satisfactory as a nurse-crop than either oats or barley. For best results, the grain used as a nurse-crop should be sown at a lower rate than when sown alone.

8. Fallow or corn-land is recommended for seeding down. Stubble-land, if free from weeds and well firmed, is usually satisfactory.

9. Alfalfa may be sown with an ordinary grain drill whether sown alone or with a nurse-crop. Sowing with a seeder attachment is preferable as it ensures more even distribution of the seed and usually earlier germination on account of shallower seeding.

10. Too thick a stand invariably lowers the yield. Seeding at the rate of 8 to 10 pounds per acre is recommended, and slightly more when a nurse-crop is used.

11. When sown alone, clipping the field occasionally and leaving a high stubble encourages root development and prevents weeds producing seed. When a nurse-crop is used, it is advisable to thresh the grain as soon after harvest as possible to avoid smothering the plants covered by the stooks.

12. Pasturing during the seeding-down season is decidedly detrimental.

13. Seeding in intertilled rows increases the difficulty of harvesting operations, but is preferable to the six-inch drills for seed production.

14. Breaking immediately after harvesting the first cutting and back-setting in September is effective in destroying the vegetation and is more economical than treating the sod as summer-fallow.

15. The maximum yield of good quality hay is obtained when alfalfa is cut just before full bloom. It is essential to cure the hay with the minimum loss of leaves. This can be done by using a tedder.

16. Alfalfa, as pasture, is relished by all classes of stock. Bloating may occur if pastured when moist with dew and the animals allowed to gorge themselves. Stock should be gradually accustomed to this pasture.

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